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AUTHOR Strasler, Gregg M. And Others
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ABSTRACT

Project CIVTEC was conducted through the Columbia, South Carolina State Board for Technical and Comprehensive Education in cooperation with the National Science Foundation and has developed an individualized instructional approach, based on mastery learning, for eleven core curriculum courses in Civil Engineering Technology. The basic format for each course was a combination of written modules forming a linear progression through a series of related objectives. The written material was broadened by a series of alternate media presentations for students having difficulty understanding the concepts presented in the modules. A state-wide evaluation was conducted in the final year of the project comparing the individualized approach with a more traditional lecture-based approach. (Author/RC)

An Evaluation of a State-Wide Mastery Learning Project in Civil Engineering Technology: Was It Worth It?

Gregg M. Strasler
D. Kent Sharples
James D. Smith, Jr.

State Board for Technical and Comprehensive Education
Columbia, South Carolina

Abstract

Project CIVTEC was conducted through SBTCE in cooperation with the National Science Foundation and has developed an individualized instructional approach, based on mastery learning, for eleven core curriculum courses in Civil Engineering Technology. The basic format for each course was a combination of written modules forming a linear progression through a series of related objectives. The written material was broadened by a series of alternate media presentations for students having difficulty understanding the concepts presented in the modules. A state-wide evaluation was conducted in the final year of the project comparing the individualized approach with a more traditional lecture-based approach.

A paper presented at the annual meeting of the American Educational Research Association, New York City, New York, 1977.

An Evaluation of a State-Wide Mastery Learning Project in Civil Engineering Technology: Was It Worth It?[1]

Gregg M. Strasler
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Introduction

The purpose of the National Science Foundation (NSF) grant was to develop an individually-paced instructional format for a state-wide Civil Engineering Technology curriculum in South Carolina. In the past three years, approximately 160 competencies were identified for eleven core courses in the civil engineering program. The basic format for each course was a combination of written modules forming a linear progression through a series of related objectives. In some cases the written material was broadened by a series of media presentations for students having difficulty understanding particular concepts presented in the modules.

In an effort to determine the effectiveness of the materials developed, a state-wide evaluation was conducted during the fall, winter, and spring quarters of the 1975-1976 academic year. The evaluation basically utilized a pretest/posttest design to compare students taught by an individually-paced instructional format to students taught by a more conventional lecture-based approach.

Definitions of Experimental and Control Strategies

As mentioned in the Introduction, two instructional strategies were utilized in the evaluation: the individually-paced method and the lecture based method. These teaching strategies will be referred to as the experimental and control strategies, respectively. A brief introduction to these instructional formats is outlined below.

(1) Individually-Paced Method of Instruction (Experimental)

The individually-paced curriculum is similar to Keller's Personalized System of Instruction (PSI) in that it focuses on individual learning based on small units of instruction. These units of instruction are in the form of modules which are usually completed by the student in a week's time or less. Like PSI, this method of instruction is individual-oriented rather than group-oriented. However, there are essential differences between the Keller plan and the individually-paced curriculum. Some of these differences are: (1) students move through the modules (learning units) at a prespecified pace; (2) a demonstration of mastery (80%-95%) is required at the end of each module before the student is permitted to continue into the next module (however, these module posttests do not count toward the student's final grade); (3) slide-tape presentations and other alternative (non-reading) learning methods are available for individual use within each module; and, (4) the student's final grade is determined primarily by his performance on a final exam (instructors had the option of using a mid-term as well).

1 Consulting services were provided by Dr. Garrett K. Mandeville and Dr. Lorin W. Anderson of the University of South Carolina. The project staff, however, assumes full responsibility for the final interpretation of the results.

(2) Lecture-Based Instructional Method (Control)

One of the most common types of instructional strategies, lecture-based instruction, is basically textbook oriented. The instructor plays the vital role of lecturing on key ideas and concepts specified by the course objectives. The lecture-based method is a group-based strategy where the time allowed for learning is relatively fixed. The course is divided into larger learning units and the student is given a test at the end of each unit which counts toward his final grade. Therefore, the student's grade is determined by his performance on the unit tests (numbering between two and four in most cases) as well as his performance on the final exam.

Although these instructional strategies were purposely contrasted, the evaluation procedures should not favor one strategy over the other. All of the testing instruments used to measure student performance were based on prespecified course objectives developed by the instructors on the NSF grant. With the exception of one out-of-state instructor, all of the instructors were quite familiar with the objectives of each course.[1] In viewing the distinctive features of the instructional strategies, all instructors had copies of the modules and objectives contained with each course. Aside from the characteristics noted above, the instructional strategies differed on one important point: the individually-paced method utilized the instructor as a manager of student learning, whereas the lecture-based method enabled the instructor to become the main dispenser of information. The objectives were already stated and in written format (i.e., in modular form) for the individually-paced approach, whereas the dissemination of objectives and written format was primarily the responsibility of the instructor in the lecture-based approach. In essence, both instructional stragegies were designed to emphasize student learning with respect to the same course objectives. A basic difference between the instructional strategies was the way in which these objectives were approached.

Data Source

The sample consisted of 250 male students enrolled in two-year, post high school engineering technology programs. Of this total, 220 students were located in seven technical education colleges throughout the state of South Carolina, and 30 students were located in one community college in North Carolina. In all of the two-year institutions, the majority of students ranged from eighteen to twenty-two years of age (65%), were non-veterans (70%), and were enrolled in a civil engineering program (65%). Those students not enrolled in civil engineering programs (35%) were enrolled in related engineering fields (e.g., engineering technology, architecture, building construction, and engineering graphics).

Assignment to Groups

Instructors were allowed to choose the instructional format (individually-paced or lecture-based method) they preferred. This procedure for assigning instructors to treatment groups presents a possible methodological problem: a self-selection of

1 The out-of-state instructor taught civil engineering courses at a two-year community college in North Carolina. This community college was used in attempting to answer Problem Statement 4.

teachers into treatment groups that is probably not random. While random assignment of teachers to treatment groups may be construed as a methodological ideal, true randomization and experimental design in a school setting are nearly impossible to attain from a practical viewpoint. Given the diverse nature of the two instructional formats, the instructors would have likely chosen the teaching method with which they were most comfortable and presumably, most likely to be successful. In essence, allowing instructors to select teaching method was viewed as a strength, not a weakness, of the evaluation.

Design of the Analysis

A one-way analysis of variance design was the basic strategy for analyzing the results of the evaluation. The design includes the effect due to treatment (experimental vs. control groups). The model for the analysis was:

$Y = \mu + T + E$, where
Y = the dependent variable,
μ = the grand mean,
T = the treatment effect, and
E = random error.

The treatment effect was tested by comparing the mean square due to treatment against the mean square due to random error.

Limitations of the Study

The design of the analysis appears to utilize a rather simplistic model given the relative complexity of the evaluation problem statements. In addition to the effect due to treatment, a more appealing analysis would have been to include campus as a factor as well as classes nested in campus and subjects nested in classes. Interaction effects such as treatment by campus would also have been appropriate in a more sophisticated analysis of variance design.

The main deterrent to using a more sophisticated design was the limited number of classes evaluated in each course. In some instances, only a single class in one course was evaluated; in other cases, there were four or five classes evaluated per course. The lack of appropriate numbers of classes was primarily due to the fact that course materials were not sufficiently developed in time to evaluate them. In some cases, classes were rescheduled or cancelled; in other cases, classes were eliminated because instructors were not implementing the instructional strategies as they were operationally defined. The small number of classes per course, therefore, eliminated the possibility of incorporating analysis of variance design models using such terms as classes nested in campus and treatment by classes nested in campus interaction. The evaluation might have been more profitable had fewer courses with a larger number of classes been investigated. Nevertheless, all of the courses sufficiently developed during the evaluation were analyzed.

Results

This section deals primarily with the analysis of the six evaluation problem statements cited in the Introduction. Appropriate tables are placed at the end of each problem statement to preserve reading continuity.

Problem Statement 1

Do students learn more under the individually-paced curriculum than under more conventional teaching methods?

In an effort to resolve this issue, cognitive achievement in ten Civil Engineering Technology courses was analyzed with respect to two operationally defined instructional strategies: an individually-paced method and a lecture-based method. For each particular course, a fifty-item summative test was administered to students both as a pretest and as a posttest. Each summative test was constructed from a crude table of specifications tapping the content covered and behavior level required.[1] In addition to the summative tests, students were also required to take three subtests (Reading Skills, Mathematical Usage and Nonverbal Reasoning) of the Career Planning Profile (CPP).

The CPP subtests and the Summative Pretest were administered in each course to assess student entry behaviors.[2] Results of these measures may be found in Tables 1 and 2. Table 1 displays the Pearson product-moment correlations of the CPP subtests and the Summative Pretest with the Summative Posttest by instructional method (individually-paced vs. lecture-based) in each of the ten Civil Engineering Technology courses. In essence, Table 1 shows the relationship between student entry behaviors and student exit behaviors. The results portrayed in Table 1 were sporadic: the correlations ranged from -0.87 to +0.70. With approximately half of all the correlation coefficients falling within a range of ±0.30, relatively few significant correlations were found. These sporadic results may have been due, in part, to the low numbers of students in both experimental and control groups within particular courses.

Despite the sporadic results observed in Table 1, an attempt was made to see whether student entering behaviors in particular courses were significantly different with respect to treatment (e.g., experimental vs. control). With treatment as the main effect, one-way analyses of variance were performed using the Summative Pretest and two of the CPP subtests (Reading Skills and Mathematical Usage) as dependent variables

1 A rating scale was devised to determine the essential course content needed to be covered and completed by the "average" student within an eleven week quarter. Instructors were asked to rate each of the course objectives with one of three alternatives: "crucial," "useful but not essential," or "not important." The behavior level of an item was classified as either "knowledge" or "comprehension." Knowledge items were stated in a form similar to that in which the content was taught. Comprehension items were stated in forms at higher levels than knowledge items; that is, comprehension items included the levels of comprehension, application, and analysis described in Bloom's taxonomy (Bloom, B.S. *Taxonomy of Educational Objectives: Cognitive Domain.* David McKay Company, Inc. New York. 1965).

2 In this context, *student entry behaviors* are defined as the aptitude and/or achievement measures students possess *prior to instruction* (or, in this instance, prior to taking a particular course). *Student exit behaviors*, on the other hand, are defined as those measures students possess *after receiving instruction*. Student entry behaviors were assessed bacause students were not randomly assigned to experimental and control classes.

in each of the ten Civil Engineering Technology courses.[1] Results in Table 2 indicate that there were no statistically significant differences found (with the exception of the math subtest in Structural Steel) between the experimental and control groups on the reading and math subtests. On the other hand, there were statistically significant differences observed between the two groups on the Summative Pretests in four of the five courses analyzed. Statistically significant differences favoring the control group were found in the following three courses: Highway Design and Construction, Surveying I and Structural Steel.[2] In summary, the student entering behaviors measured did not appear to favor the experimental group. In terms of the reading and math subtests of the CPP, the two groups were relatively equal; in terms of the Summative Pretest, the control group maintained a slight advantage.

Student exit behaviors, as measured by the Summative Posttest in each course, were analyzed in the same manner as the student entry behaviors.[3] One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 2. Due to an absence of an experimental group or a control group, only six of the ten courses could be analyzed in this fashion.[4] Statistically significant differences favoring the experimental group were found in three of the six courses: Highway Design and Construction, Structural Steel and Structural Concrete. In the case of the first two courses mentioned, statistically significant differences favoring the control group were found on the Summative Pretest; in the case of Structural Concrete, statistically significant differences favored the experimental group on the Summative Pretest. Although not statistically significant, differences in favor of the experimental group were also found in the Surveying I and Surveying II Summative Posttests.[5]

1 The CPP Nonverbal Reasoning subtest was not included in the analysis for two reasons. First of all, this subtest was negatively correlated to more of the Summative Posttests than were the reading and math measures. In addition, only one of the correlations was found to be statistically significant. The reader should also note that comparisons between experimental and control groups could only be made in six of the ten courses using the reading or math subtests as dependent variables and in only five courses using the Summative Pretest as the dependent variable.

2 The reader should note that the mean of the experimental group in Structural Steel ($\bar{X}_E = 8.2 < \bar{X}_C = 13.7$) and the mean of the control group in Structural Concrete ($\bar{X}_C = 7.4 < \bar{X}_E = 20.6$) were quite low. By chance alone, a student should be able to guess correctly on twelve to thirteen items on a fifty item test with four alternatives per item. The low means noted possibly indicate that students were not really trying on these particular Summative Pretests.

3 The reader may question analyzing the Summative Posttests without using some or all of the student entry behaviors as covariates. Although one of the uses of analysis of covariance is to increase precision, the results in Table 1 indicate that neither the CPP subtests nor the Summative Pretest were correlated consistently high enough with the Summative Posttest to be used as covariates.

4 Four of the courses contained only an experimental or control group. Of these four courses, three were individually-paced. The experimental groups in Statics, Cost Estimating and Soil Mechanics made Summative Pretest/Summative Posttest mean gains of 16.1, 11.6 and 11.0 raw score points. In the one course using the lecture-based method (Strength of Materials), the Summative Pretest/Summative Posttest mean gain of the control group was 3.4 raw score points.

5 In the case of Surveying I, statistically significant differences in favor of the control group were found on the Summative Pretest. No significant differences were observed on the Surveying II Summative Pretest.

Differences favoring the control group were found in only one course, Hydraulics, although this difference was not statistically significant. In terms of student entry and exit behaviors, then, the individually-paced students appear to have made more cognitive gains than those students taught by the lectured-based method of instruction.

As an interesting sidelight, the results of the Summative Pretest and Summative Posttest are also presented in Table 3. This table includes the means, standard deviations and raw score ranges of the experimental and control groups in the ten Civil Engineering Technology courses evaluated. Based on Bloom's (1976) thinking concerning individual differences, one would expect that the variation of scores on the Summative Posttests would be less for individually-paced students (where "mastery" was required) than for lecture-based students.[1] With the exception of Surveying II, Hydraulics, and Structural Concrete, however, just the opposite was true: the standard deviations and raw score ranges of the Summative Posttests were slightly larger in individually-paced courses than in lecture-based courses. In essence, there appeared to be as much variability among individually-paced students as there was with lecture-based students in terms of student exit behaviors. This increased variability may be, in part, attributed to the emphasis placed on individual learning rather than on group learning.

1 Bloom, B.S. Human Characteristics and School Learning. New York: McGraw-Hill, 1976.

Table 1 . Pearson product-moment correlations of summative pretest, CPP subtests (reading, math, and nonverbal) with summative posttest in ten civil engineering technology courses.

	Summative Pretest		CPP Reading		CPP Math		CPP Nonverbal	
COURSE	r_C	r_E	r_C	r_E	r_C	r_E	r_C	r_E
Highway Design and Construction	-0.38 (11)	0.03 (33)	-0.13 (8)	0.22 (23)	0.26 (8)	0.30 (23)	-0.23 (8)	0.03 (23)
Surveying II	0.52* (16)	0.20 (8)	0.47 (15)	0.44 (12)	0.22 (15)	0.52 (12)	0.38 (15)	0.45 (12)
Statics	-	0.38** (47)	-	0.13 (40)	-	0.29 (40)	-	0.08 (39)
Surveying I	0.50 (13)	0.32 (19)	0.63* (12)	0.70** (26)	0.51 (12)	0.50** (26)	-0.24 (12)	0.58** (26)
Structural Steel	0.08 (31)	-0.42** (39)	0.26 (28)	0.31 (32)	0.33 (28)	0.43** (32)	0.30 (28)	0.32 (31)
Strength of Materials	-0.16 (7)	-	0.09 (6)	-	-0.87* (6)	-	-0.04 (5)	-
Hydraulics	-	-	0.44 (12)	0.42 (9)	0.13 (12)	0.50 (9)	0.27 (12)	0.59 (9)
Cost Estimating	-	0.10 (14)	-	0.18 (10)	-	0.07 (10)	-	-0.03 (10)
Structural Concrete	-0.53** (21)	0.35 (14)	-0.18 (13)	0.09 (13)	0.59* (13)	0.27 (13)	0.33 (13)	0.26 (13)
Soil Mechanics	-	-0.19 (10)	-	0.12 (8)	-	0.25 (8)	-	-0.27 (8)

<u>NOTE:</u>

r_C = product-moment correlation in control group

r_E = product-moment correlation in experimental group

Asterisks indicate degree of significance: * ($P < .05$), ** ($P < .01$)

Table 2. Analysis of variance results for summative posttests, pretests and CPP subtests (reading and math) in ten civil engineering technology courses.

	Summative Posttest				Summative Pretest				CPP Reading				CPP Math			
COURSE	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P
Highway Design and Construction	24.9 (10)	35.5 (33)	33.46 (1,39)	<.01	22.1 (11)	18.7 (33)	6.71 (1,40)	<.01	29.5 (8)	31.2 (23)	0.36 (1,27)	N.S.	9.5 (8)	11.1 (23)	1.06 (1,27)	N.S.
Surveying II	37.5 (16)	39.1 (15)	0.89 (1,29)	N.S.	23.3 (16)	23.9 (8)	0.07 (1,22)	N.S.	31.7 (15)	29.8 (12)	1.09 (1,25)	N.S.	11.7 (15)	9.7 (12)	2.56 (1,25)	N.S.
Statics	-	34.0 (51)	-		-	17.9 (47)	-		-	29.4 (40)	-		-	10.7 (40)	-	
Surveying I	29.4 (14)	31.1 (28)	0.64 (1,39)	N.S.	20.4 (13)	17.1 (19)	6.93 (1,29)	<.05	32.3 (12)	29.0 (26)	2.39 (1,35)	N.S.	10.2 (12)	9.1 (26)	0.69 (1,35)	N.S.
Structural Steel	22.0 (30)	27.4 (38)	20.3 (1,61)	<.01	13.7 (31)	8.2 (39)	71.6 (1,63)	<.01	31.3 (28)	31.4 (32)	0.02 (1,53)	N.S.	10.4 (28)	12.3 (32)	4.61 (1,53)	<.05
Strength of Materials	19.7 (7)	-	-		16.3 (7)	-	-		32.3 (6)	-	-		13.0 (6)	-	-	
Hydraulics	32.1 (13)	30.5 (22)	0.72 (1,33)	N.S.	-	-	-		32.7 (12)	30.0 (9)	1.58 (1,19)	N.S.	12.4 (12)	14.2 (9)	1.50 (1,19)	N.S.
Cost Estimating	-	33.6 (14)	-		-	22.0 (14)	-		-	32.1 (10)	-		-	12.4 (10)	-	
Structural Concrete	22.2 (21)	35.4 (14)	95.03 (1,32)	<.01	7.4 (21)	20.6 (14)	125.23 (1,32)	<.01	30.6 (13)	33.4 (13)	2.59 (1,23)	N.S.	12.2 (13)	10.6 (13)	1.33 (1,23)	N.S.
Soil Mechanics	-	27.3 (10)	-		-	16.3 (10)	-		-	32.1 (8)	-		-	9.9 (8)	-	

NOTE:
$\bar{X}_C$ = mean of control group
$\bar{X}_E$ = mean of experimental group

Table 3 . Descriptive statistics for summative pretests and summative posttests in ten civil engineering technology courses.

COURSE	Treatment Group	Summative Pretest Mean and Standard Deviation	Summative Posttest Mean and Standard Deviation	Raw Score Range	
				Pretest	Posttest
Highway Design and Construction	Control	22.1 (4.0)	24.9 (3.3)	15-27	16-27
	Experimental	18.7 (4.3)	35.5 (5.9)	9-25	21-43
Surveying II	Control	23.3 (5.0)	37.5 (5.7)	17-31	25-45
	Experimental	23.9 (5.2)	39.1 (3.7)	17-30	35-47
Statics	Control	-	-	-	-
	Experimental	17.9 (4.7)	34.0 (7.4)	9-28	18-46
Surveying I	Control	20.4 (2.9)	29.4 (4.6)	15-24	19-36
	Experimental	17.1 (3.9)	31.1 (7.3)	12-24	14-43
Structural Steel	Control	13.7 (2.9)	22.0 (6.0)	7-20	14-33
	Experimental	8.2 (5.7)	27.4 (7.0)	0-18	14-43
Strength of Materials	Control	16.3 (5.9)	19.7 (7.8)	9-24	7-28
	Experimental	-	-	-	-
Hydraulics	Control	-	32.1 (5.5)	-	26-41
	Experimental	-	30.5 (5.2)	-	21-41
Cost Estimating	Control	-	-	-	-
	Experimental	22.0 (3.9)	33.6 (4.9)	15-27	20-40
Structural Concrete	Control	7.4 (8.0)	22.2 (4.5)	0-23	15-32
	Experimental	20.6 (3.7)	35.4 (4.4)	15-27	28-43
Soil Mechanics	Control	-	-	-	-
	Experimental	16.3 (3.3)	27.3 (3.0)	11-21	24-32

NOTE:

The "Raw Score Range" denotes the lowest and highest score (number of items correct) recorded on each fifty (50) item summative pretest and summative posttest.

Problem Statement 2

An individually-paced curriculum may produce a very different grade distribution than that seen in a conventional course, as many more students may receive A's and B's in an individually-paced curriculum. Are these higher grades justified?

Instructors were required to make available the final letter grades they assigned to their students in the spring quarter. Structural Concrete was the only course analyzed because of the limited number of classes in the other spring courses. In Structural Concrete, there were two control classes of eight and twelve students, and one experimental class of fourteen students. The results observed in this section should be interpreted with caution due to the fact that only one course with a limited number of classes was analyzed.

A one-way analysis of variance was used to analyze the results. Table 4 indicates there were no significant differences between experimental and control groups with respect to final grades assigned. In fact, final grades were slightly higher for the control classes ($\bar{X}_C = 3.3$) than for the experimental class ($\bar{X}_E = 3.2$).

The grade distribution for the experimental and control classes reveals the following information:

Grade Distribution Percentages

	A	B	C	D	F
Experimental (N = 14)	36%	50%	14%	-	-
Control (N = 20)	45%	35%	15%	5%	-

In both the experimental and control classes, the majority of students received "A's" or "B's" (86% in the experimental group vs. 80% in the control group). A chi-square value of 0.19 was obtained by comparing the proportion of "A's" and "B's" to the proportion of "C's" and "D's" in the experimental and control groups. With one degree of freedom, this chi-square value was not significant. In the case of Structural Concrete, there appears to be no dependent relationship between grades assigned and instructional method used.

The last portion of the problem statement deals with the question of whether higher grades in an individually-paced curriculum are justified. This question would have been applicable if there had been differences observed in the means of the final grades assigned in the experimental and control groups; however, there were no significant differences observed. If differences in grades had been observed, the problem of justification might have been demonstrated by using analysis of covariance (ANCOVA) with the Summative Posttest as a covariate and, hopefully, achieving non-significance (with the assumption that Summative Posttest differences observed would be "adjusted for" in the ANCOVA).

Table 4. Analysis of variance results for final grades assigned in Structural Concrete.

	Final Grades Assigned			
Course	$\overline{X}_C$	$\overline{X}_E$	$F_{(df)}$	P
Structural Concrete	3.3 (20)	3.2 (14)	0.02 (1,31)	N.S.

NOTE:

$\overline{X}_C$ = mean of control group

$\overline{X}_E$ = mean of experimental group

Grades were determined by the following scoring scheme: A=4, B=3, C=2, D=1, F=0

Problem Statement 3

Do individually-paced students exhibit a significantly different long-term retention of facts and concepts than students taught by a lecture method?

Ten weeks after a Summative Posttest in Structural Steel had been administered, a twenty-item Retention Test was given to twenty-five students taught by the lecture-based method and to twelve students taught by the individually-paced method. The Retention Test was considerably shorter than the Summative Posttest so that it could be administered in a one hour time period.[1]

From the results observed in Problem Statement 1, students in individually-paced classes significantly outperformed students in lecture-based classes on the Structural Steel Summative Posttest. This same level of significance is also observed in Table 5, where the means of the Summative Posttest in Structural Steel are based on twenty items rather than on fifty items.[2]

1 The Retention Test was merely a shortened version of the Structural Steel Summative Posttest. Twenty items were selected by an instructor who had taught the Structural Steel course by the lecture-based method. As in the Summative Posttest, 40% of the retention items were classified as knowledge items and 60% were classified as comprehension items.

2 Two points need to be emphasized. First of all, only the twenty "common" items included on both the Retention Test and the Summative Posttest in Structural Steel were used in the analysis. Secondly, the reader will note there were fewer students (N = 38) receiving the Retention Test than there were students (N = 68) receiving the Summative Posttest. The loss of students was primarily due to administrative difficulties.

One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 5. Although the results were not significantly different ($P = 0.07$), the experimental group scored higher than the control group on the Retention Test ($\bar{X}_E = 9.9 > \bar{X}_C = 7.9$); however, the question of initial performance on the Summative Posttest must be resolved.

Two methods of analysis were used to investigate "retention" in terms of the initial performance on the Summative Posttest. The first method involved analysis of the experimental and control groups in terms of "pure retention." A "Difference Score," calculated by subtracting the mean of the Retention Test from the mean of the Summative Posttest, is presented in Table 5. In terms of "pure retention," the experimental students appear to have lost more than the control students in the absolute sense ($\bar{X}_E = 4.2 > \bar{X}_C = 1.7$) although the experimental students scored higher overall on the Retention Test. The second method regressed the Retention Test scores onto the Summative Posttest scores for the control group. Prediction of the Retention Test score for the experimental group was obtained and compared to the actual Retention Test score.[1] A one-tailed t-test ($t = 0.57$) revealed that the difference between the actual value and the predicted value of the Retention Test score for the experimental group was not significantly different from zero.[2]

One final method was used to analyze the Retention Test results. Table 6 reveals chi-square results for each of the Structural Steel retention items. In accordance with the two methods of analysis used above, initial differences in Summative Posttest performance were taken into account by analyzing only those students who got a specific item correct on the Summative Posttest. A 2 X 2 contingency table of the following form appeared appropriate in analyzing the twenty Retention Test items:

		E	C
Retention Test	correct		
	incorrect		
		N_E	N_C

where N_E and N_C are the number of students in the experimental and control groups who answered the item correctly on the Summative Posttest.

1 The predicted Retention Test score of the experimental group was obtained from the following regression equation: $Y = 3.57 + 4.18$ (Posttest Score). The predicted Retention Test score of the experimental group ($Y = 9.46$) was then subtracted from the actual Retention Test Score ($\bar{X}_E = 9.92$) observed in Table 5. A difference of 0.46 was observed between the predicted and actual (observed) Retention Test score for the experimental group.

2 The t-value was calculated as follows:

$$t = \frac{0.46}{2.806/\sqrt{12}} = 0.57$$

To observe whether item retention differed between experimental and control groups, a chi-square analysis was applied to the contingency tables outlined in Table 6. With the exception of the first two items, the values of chi-square were not found to be significant at the 0.05 level in testing for differences in the proportions of items correct on the retention test for the two instructional methods. In essence, there appears to be no dependent relationship between the amount of item retention and the instructional method utilized.[1]

1 Although the majority of chi-square values were not found to be significant, Table 6 merits further investigation. The proportions of students answering retention items correctly appear to be slightly in favor of the experimental method. There were only three clear-cut cases in which the control students outperformed the experimental students (i.e., items 10, 13, and 15); on the other hand, there were nine items which favored the experimental students (i.e., items 1, 2, 3, 4, 5, 7, 14, 18, and 20). There appeared to be no "direction" for the eight remaining items.

Table 5 . Analysis of variance results for summative posttests, retention tests, and difference scores in Structural Steel.

	Summative Posttest*				Retention Test				Difference Score**			
COURSE	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P
Structural Steel	9.6 (25)	14.1 (12)	13.01 (1,35)	<.01	7.9 (25)	9.9 (12)	3.44 (1,35)	N.S.	1.7 (25)	4.2 (12)	5.54 (1,35)	<.05

NOTE:

$\bar{X}_C$ = mean of control group

$\bar{X}_E$ = mean of experimental group

* The means of the Summative Posttest in this table are based only on the 20 items used for the Retention Test in Structural Steel.

** The Difference Score is calculated by subtracting the mean of the Retention Test from the mean of the Summative Posttest.

Table 6 . Chi-square results of structural steel retention items.

Item Number	Classification	Treatment Group	Correct Responses	Incorrect Responses	X^2(1df)	P
1	Comprehension	Control	0	11	13.55	<.01
		Experimental	9	3		
2	Knowledge	Control	2	7	5.40	<.01
		Experimental	5	1		
3	Comprehension	Control	5	11	1.47	N.S.
		Experimental	6	5		
4	Comprehension	Control	19	5	2.67	N.S.
		Experimental	11	0		
5	Comprehension	Control	3	10	1.38	N.S.
		Experimental	3	3		
6	Comprehension	Control	6	3	0.14	N.S.
		Experimental	6	2		
7	Comprehension	Control	4	9	0.50	N.S.
		Experimental	2	2		
8	Comprehension	Control	8	8	0.07	N.S.
		Experimental	4	5		
9	Knowledge	Control	13	6	0.07	N.S.
		Experimental	7	4		
10	Knowledge	Control	2	2	0.90	N.S.
		Experimental	1	4		
11	Comprehension	Control	8	6	0.16	N.S.
		Experimental	4	2		
12	Comprehension	Control	7	8	0.00	N.S.
		Experimental	5	6		
13	Comprehension	Control	9	6	0.21	N.S.
		Experimental	4	4		
14	Comprehension	Control	4	9	2.17	N.S.
		Experimental	4	2		
15	Comprehension	Control	9	3	2.03	N.S.
		Experimental	4	5		
16	Knowledge	Control	0	4	1.56	N.S.
		Experimental	1	2		
17	Knowledge	Control	10	1	1.98	N.S.
		Experimental	8	4		
18	Knowledge	Control	4	5	2.57	N.S.
		Experimental	8	2		
19	Knowledge	Control	11	3	0.68	N.S.
		Experimental	7	4		
20	Knowledge	Control	0	0	insufficient data for χ^2	
		Experimental	3	7		

NOTE:

The number of total responses (correct responses and incorrect responses) within treatment group varies from item to item. This is due to the fact that only students correctly answering items on the summative posttest were analyzed on the respective retention test items.

Problem Statement 4

Can the individually-paced curriculum materials developed by a given instructor be used in another institution with roughly equivalent results? That is, are well-written individually-paced curriculum courses relatively independent of the actual instructor, provided the instructor using them understands how the individually-paced curriculum works?

An attempt was made to answer the above problem in part by using some of the individually-paced materials in an institution outside the state of South Carolina. Sandhills Community College, a two-year institution located in North Carolina, agreed to participate in the evaluation by using the individually-paced instructional method. Two experimental classes, one in Highway Design and Construction and another in Surveying II, were taught during the spring quarter in Sandhill's Civil Engineering Technology program.

The general characteristics of the engineering technology students in Sandhills Community College compared favorably to the technology students enrolled in the South Carolina schools. The majority of Sandhill's engineering technology students ranged in age from eighteen to twenty-two years of age (65%), were non-veterans (75%), and were enrolled in civil engineering programs (65%). Those students not enrolled in civil engineering programs (35%) were enrolled in architectural technology, a related engineering field.

The students enrolled in the two experimental classes at Sandhills were also compared in terms of student entering behaviors to the South Carolina students enrolled in the experimental classes in Highway Design and Construction and Surveying II. Table 7 indicates there were no significant differences observed on the raw scores of the CPP reading and math subtests between the two experimental groups (South Carolina schools vs. Sandhills Community College) in either the Highway Design and Construction or the Surveying II courses. There appeared to be no distinct differences between the experimental groups in terms of general characteristics and student entering behaviors.

The two experimental groups were compared on the Summative Pretests and Summative Posttests administered in the two courses. One-way analysis of variance results using treatment (experimental: South Carolina vs. Sandhills) as the main effect may be observed in Table 7. The results concerning the Highway Design and Construction course are confounded by the fact that five items (items 51-55) were missing on the Summative Pretest and Summative Posttest administered to the experimental group in North Carolina; therefore, interpretation of these results is suspect.[1]

With respect to the Surveying II course, Table 7 reveals there were no significant differences between the two experimental groups on the summative tests. Both groups appeared to do equally well on the Summative Pretest ($\bar{X}_{E1} = 23.9 \approx \bar{X}_{E2} = 20.9$) and the Summative Posttest ($\bar{X}_{E1} = 39.1 \approx \bar{X}_{E2} = 38.1$) in Surveying II. Although the data is somewhat limited, the results from the Surveying II course tend to support the idea that the individually-paced curriculum could be used effectively elsewhere.

1 Although there were five missing test items for the North Carolina students, they significantly outperformed the South Carolina students on the Summative Pretest; however, the North Carolina students were significantly behind the South Carolina students in terms of the Summative Posttest.

Table 7. Analysis of variance results for summative posttests, pretests and CPP subtests (reading and math) in two civil engineering technology courses.

	Summative Posttest				Summative Pretest				CPP Reading				CPP Math			
COURSE	$\overline{X}_{E1}$	$\overline{X}_{E2}$	$F_{(df)}$	P	$\overline{X}_{E1}$	$\overline{X}_{E2}$	$F_{(df)}$	P	$\overline{X}_{E1}$	$\overline{X}_{E2}$	$F_{(df)}$	P	$\overline{X}_{E1}$	$\overline{X}_{E2}$	$F_{(df)}$	P
Highway Design * and Construction	35.5 (33)	31.0 (11)	5.84 (1,40)	<.05	18.7 (33)	23.0 (11)	11.1 (1,40)	<.01	31.2 (23)	28.8 (10)	1.90 (1,29)	N.S.	11.1 (23)	10.5 (10)	0.15 (1,29)	N.S.
Surveying II	39.1 (15)	38.9 (14)	0.04 (1,27)	N.S.	23.9 (8)	20.9 (10)	0.71 (1,16)	N.S.	29.8 (12)	27.0 (11)	1.46 (1,21)	N.S.	9.7 (12)	9.7 (11)	0.00 (1,21)	N.S.

NOTE:

$\overline{X}_{E1}$ = mean of experimental group in South Carolina

$\overline{X}_{E2}$ = mean of experimental group in North Carolina (Sandhills Community College)

* Five items were missing on the summative pretest and posttest administered to the experimental group in North Carolina which may account for some of the differences noted.

Problem Statement 5

The majority of people who have taught self-paced courses have experienced the "procrastination" problem evidenced by a significant number of students who progress through a course at a rate much slower than average. What are the various causes of procrastination and how may a course be designed to minimize the problem?

Two instruments were used in attempting to answer the problem statement: a Course Questionnaire and an Instructor Questionnaire.

As noted in the problem statement, a procrastinator is defined as a student who progresses through a course at a rate much slower than average. In an effort to identify procrastinators in both individually-paced and lecture-based groups, the definition of procrastinator was expanded to include any student who dropped a course, received an incomplete, or failed a course.

Of the total number of students identified as procrastinators in the fall, winter, and spring quarters (N = 53, 58% responded to the Course Questionnaire. The general characteristics of those responding to the Course Questionnaire compared favorably to the total sample of 250 students: the majority of procrastinators ranged from eighteen to twenty-two years of age (62%), were non-veterans (70%), and were enrolled in a civil engineering program (75%).

To observe whether the rate of procrastination differed between the two instructional methodologies employed, a chi-square analysis was applied to the contingency tables in Table 8. The values of chi-square were not found to be significant at the 0.05 level in testing for independence of procrastination and instructional method. A chi-square value of 1.36 was observed for the classification of procrastinators (e.g., students dropping a course, receiving an incomplete, or failing a course) and students passing a course versus instructional method. A chi-square value of 0.50 was observed for the classification of students dropping and students passing a course versus instructional method. Therefore, there appears to be no dependent relationship between the amount of procrastination and the type of instructional method utilized. There was no observed tendency for students to procrastinate more in individually-paced courses than in lecture-based courses. However, one should be reminded that the individually-paced approach was not totally self-paced; that is, students were given guidelines to move through the modules (learning units) at a prespecified pace. Also, students in the experimental group were required to take the final exam (Summative Posttest) at the end of the quarter and were sometimes required to take a midterm: therefore, the requirements of the individually-paced instructional method may have deterred procrastination evident in many self-paced instructional approaches.

A section entitled "Course Evaluation" in the Course Questionnaire was not utilized in the evaluation. This was due to the small number of procrastinator returns per individual course. However, an open-ended "Course Comments" section was content analyzed with respect to procrastinators in the individually-paced courses. Procrastinators listed the three "major limitations" of the individually-paced format as being:

(1) too many students per class with only one instructor;
(2) too much reliance on modules (learning units) for learning; and,
(3) students must be self-motivated.

Procrastinators listed the three most common methods for "improving instruction" in the individually-paced format as being:

(1) decrease the instructor-student ratio (e.g., limit class size);
(2) introduce one lecture per week for review purposes; and,
(3) prepare a schedule ("time table") for the completion of each module; enforcement of this schedule will help motivate students to complete a course.

The procrastinators in individually-paced courses appeared to be asking for more instructor input as well as for a more rigidly defined course time-table.

Instructors were asked on the Instructor Questionnaire to list the three major advantages and disadvantages of the particular instructional format (individually-paced or lecture-based) used. Listed below are the three major advantages and disadvantages for the two types of instruction.

(1) Individually-Paced Method

A. Advantages:

1. Students may progress at a pace consistent with their abilities.
2. A student may be recycled until acceptable mastery of individual learning objectives is attained.
3. The student is primarily responsible for learning.

B. Disadvantages:

1. The instructor-student dialogue (interaction) is impaired.
2. There are larger demands upon instructor time (dependent directly on the instructor-student ratio).
3. Students have a tendency to procrastinate and fall behind schedule.

(2) Lecture-Based Method

A. Advantages:

1. The instructor has control over the class as a group.
2. Classroom discussion and instructor-student interaction is enhanced.
3. The instructor's time is effectively utilized.

B. Disadvantages:

1. The instructional method is geared toward the average and below average student; coverage of the materials is limited for the best students.
2. A student must take regularly scheduled exams regardless of his degree of achievement.
3. Many students do not become actively involved in the learning process.

Generally speaking, instructors using the individually-paced strategy stressed the importance of that method in terms of student ability and motivation. Instructors utilizing the experimental method emphasized not only that learning was primarily the responsibility of the student, but also that learning should take place in the framework of the student's ability. Viewing the disadvantages of the experimental method, the instructor-student ratio appears to be a critical feature. If the instructor-student ratio is reasonable, the disadvantages of the individually-paced method appear to be

minimal.[1]

Instructors using the lecture-based method appeared to emphasize the importance of the class as a group. The instructors using the control method stressed the importance of class control as well as class discussion. These instructors also felt their time was utilized more effectively. In observing the disadvantages cited by the instructors in the lecture-based method, there appears to be a concern for the student as an individual with respect to ability level and motivation. These very characteristics were the ones emphasized in the advantages of the individually-paced instructional method.

Table 8 . Contingency tables showing the relationship between procrastination and instructional method for 498 and 488 subjects, respectively.

	Number of Procrastinators	Number of Students Passing	Total
Individually-Paced Method	42	319	361
Lecture-Based Method	11	126	137
Total	53	445	498

$$X^2_{(1df)} = 1.36, \text{ N.S.}$$

1 In speaking with the instructors employing the individually-paced instructional method, the consensus for a workable ratio appeared to be one instructor for ten students or less.

Table 8 . Continued

	Number of Students Dropping	Number of Students Passing	Total
Individually-Paced Method	33	319	352
Lecture-Based Method	10	126	136
Total	43	445	488

$X^2(1df) = 0.50$, N.S.

NOTE: The frequencies of incompletes and failures noted below were not high enough to perform chi-square analysis.

	Drops	Incompletes	Failures	Passing	Total
Individually-Paced Method	33	6	3	319	361
Lecture-Based Method	10	1	0	126	137
Total	43	7	3	445	498

Problem Statement 6

Do students under an individually-paced curriculum display a more positive affect toward subject matter than students under more conventional teaching methods?

A fifty item Likert scale (Course Evaluation) was administered to all students at the completion of each course. The Course Evaluation comprised eight subscales which were logically validated. The Course Evaluation was further validated empirically through the use of a factor analysis technique.

The technique of principal components analysis was employed using all subjects' responses (both experimental and control), experimental subjects' responses, and control subjects' responses. Results of the factor analysis on the Course Evaluation indicated fifteen major rotated factors (a varimax rotation), each possessing eigen values greater than one (for all subjects, experimental subjects only, and control subjects only). Only items "loading" greater than or equal to 0.50 were considered in the interpretation of the factors.

Although fifteen factors were extracted, only four factors (see Table 9) were used in the analysis. These factors were chosen because they fulfilled the following criteria:

(1) Each factor had relatively few high loadings of variables (items) with the rest of the loadings very close to zero.
(2) The phraseology of each item was not biased toward the instructional method used in a course.
(3) The variables (items) loaded significantly (0.50 or greater) on both instructional methods (experimental and control).
(4) Each factor was relevant to the problem statement.

The Course Evaluation items corresponding to the four factor structures were labeled as follows:

(1) Factor I.....Course Workload and Grading.
(2) Factor II....Instructor Effectiveness.
(3) Factor III...Attitude Toward Course and Instructional Method.
(4) Factor IV....Relevancy of Course and Instructional Method.

All of the items in each of the four subscales were dichotomously scored. An item stated in a positive manner would be scored as "1" if a response to the item was "strongly agree" or "agree." An item stated in a negative manner would be scored as "1" if a response was "strongly disagree" or "disagree." Therefore, a high point total on a subscale would indicate a positive reaction to that subscale and a low point total would indicate a negative reaction. One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 10.

In general, the lecture-based method was rated more positively than the individually-paced method with respect to the four subscales described. In particular, the control group scored significantly higher in six of eight courses on both the "Instructor Effectiveness" and the "Attitude Toward Course and Instructional Method" subscales. In four of eight courses the control group scored significantly higher on the "Coursework and Grading" subscale, and, in two of eight courses, the control group scored significantly higher on the subscale entitled "Relevancy of Course and Instructional Method." The remaining courses showed no significant differences between experimental and control groups on the four subscales. The results appear to indicate that students under an individually-paced curriculum do not display a more "positive affect" toward subject matter than students under more conventional teaching methods.

Table 9 . Course evaluation items loading 0.50 or greater for both experimental and control students.

Factor I (Course Workload and Grading):

Factor Loading	Items	
0.79	(11)	In relation to other courses, the workload in this course was much heavier.
0.65	(46)	There were too many demands placed on the student.
0.62	(40)	The material presented in this course was much too difficult.
0.61	(16)	The pace of this course was too fast.
0.60	(21)	I have spent considerably more time in this course than in others.
0.55	(22)	The grading system was quite fair.
0.52	(14)	The tests were too difficult.

Factor II (Instructor Effectiveness):

Factor Loading	Items	
0.82	(17)	The instructor was quite helpful.
0.80	(5)	The instructor made himself readily available.
0.61	(44)	The instructor had a tremendous knowledge of the subject matter.
0.60	(8)	The instructor had a good understanding of the subject matter.

Factor III (Attitude Toward Course and Instructional Method):

Factor Loading	Items	
0.79	(30)	If another course were taught in this way, I would take it.
0.75	(3)	I was enthusiastic and receptive to this method of instruction.
0.65	(4)	I would recommend this course to a friend.
0.65	(28)	I was highly motivated by this method of instruction.
0.59	(36)	When other methods of instruction are used, I learn more.
0.55	(29)	My overall evaluation of this course is excellent.

Factor IV (Relevancy of Course and Instructional Method):

Factor Loading	Items	
0.66	(26)	This course caused me to make more effective use of my study time.
0.55	(39)	This method of instruction taught me to pursue the subject on my own.
0.53	(38)	This course taught me new ways to understand and evaluate problems.
0.50	(27)	The amount of useful material learned in this course was negligible.

Table 10. Analysis of variance results for four subscales of the course evaluation in ten civil engineering technology courses.

	Course Workload and Grading				Instructor Effectiveness				Attitude Toward Course and Instructional Method				Relevancy of Course and Instructional Method			
COURSE	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P
Highway Design and Construction	4.4 (11)	4.4 (47)	0.01 (1,52)	N.S.	4.0 (11)	3.1 (47)	7.30 (1,52)	<.01	3.3 (11)	2.5 (47)	1.33 (1,52)	N.S.	1.8 (11)	1.9 (47)	0.02 (1.52)	N.S.
Surveying II	2.7 (16)	3.3 (36)	1.33 (1,48)	N.S.	3.1 (16)	3.3 (36)	0.36 (1,48)	N.S.	0.9 (16)	1.9 (36)	3.12 (1,48)	N.S.	1.6 (16)	1.7 (36)	0.06 (1,48)	N.S.
Statics	-	1.7 (56)	-		-	2.9 (56)	-		-	0.8 (56)	-		-	1.5 (56)	-	
Surveying I	5.5 (14)	3.3 (28)	12.92 (1,39)	<.01	3.9 (14)	3.5 (28)	3.85 (1,39)	N.S.	4.3 (14)	2.8 (28)	6.24 (1,39)	<.05	2.0 (14)	1.8 (28)	0.41 (1,39)	N.S.
Structural Steel	3.4 (32)	1.6 (39)	18.65 (1,64)	<.01	4.0 (32)	2.5 (39)	50.38 (1,64)	<.01	3.3 (32)	1.1 (39)	39.57 (1,64)	<.01	2.4 (32)	1.3 (39)	15.39 (1,64)	<.01
Strength of Materials	3.1 (7)	1.9 (12)	2.18 (1,17)	N.S.	4.0 (7)	1.4 (12)	16.22 (1,17)	<.01	2.9 (7)	0.5 (12)	11.03 (1,17)	<.01	3.1 (7)	1.3 (12)	25.8 (1,17)	<.01
Hydraulics	5.3 (12)	2.9 (18)	10.00 (1,28)	<.01	4.0 (12)	3.4 (18)	4.62 (1,28)	<.05	4.3 (12)	1.0 (18)	36.55 (1,28)	<.01	2.4 (12)	1.7 (18)	2.03 (1,28)	N.S.
Cost Estimating	4.3 (16)	1.5 (13)	16.14 (1,27)	<.01	3.7 (16)	2.8 (13)	5.45 (1,27)	<.05	2.2 (16)	0.5 (13)	10.75 (1,27)	<.01	1.7 (16)	1.7 (13)	0.00 (1,27)	N.S.
Structural Concrete	3.7 (28)	2.6 (29)	3.63 (1,51)	N.S.	3.6 (28)	3.1 (29)	5.12 (1,51)	<.05	3.4 (28)	1.1 (29)	27.36 (1,51)	<.01	2.1 (28)	1.5 (29)	3.43 (1,51)	N.S.
Soil Mechanics	-	4.7 (10)	-		-	3.8 (10)	-		-	2.6 (10)	-		-	2.0 (10)	-	

NOTE:

$\bar{X}_C$ = mean of control group

$\bar{X}_E$ = mean of experimental group

Total points possible for each subscale:
(1) Course Workload and Grading.......................7 points
(2) Instructor Effectiveness.........................4 points
(3) Attitude Toward Course and Instructional Method...6 points
(4) Relevancy of Course and Instructional Method......4 points

Summary

The evaluation was based on a pretest/posttest design to compare two operationally defined instructional strategies: an individually-paced method and a lecture-based method. The effectiveness of the individually-paced format was determined primarily through the analysis of six evaluation problem statements. Due to the limited time allotted for the evaluation and the relatively small number of classes investigated within each course, the results must be viewed as tentative.

In terms of cognitive achievement, the individually-paced students did relatively well. Although the results were not dramatic, the individually-paced students generally outperformed the lecture-based students in terms of student exit behaviors (as measured by the Summative Posttests); however, the range of scores was slightly greater for individually-paced students than for lecture-based students. More variability in terms of student exit behaviors was not anticipated in a learning for mastery strategy. The experimental group also scored higher than the control group on a ten-week retention test in Structural Steel, although the results were not statistically significant.

In contrast to the results found in cognitive achievement, individually-paced students did not appear to display a more positive affect toward subject matter than lecture-based students. In fact, four empirically validated subscales (Course Workload and Grading, Instructor Effectiveness, Attitude Toward Course and Instructional Method, and Relevancy of Course and Instructional Method) were rated higher by lecture-based students in the majority of courses. This apparent discrepancy between the cognitive and affective domains may be related to the fact that the individually-paced instructional method was totally new to the students and that the students were required to become more active participants in the learning process.

Aside from affective and cognitive characteristics, the topics of procrastination and final grade distribution were investigated. In the evaluation, the definition of a procrastinator was expanded to include any student who dropped a course, received an incomplete, or failed a course. Using this definition, a chi-square analysis indicated there was no observed tendency for students to procrastinate more in individually-paced courses than in lecture-based courses. With respect to final grades assigned to students, a chi-square analysis in one course (Structural Concrete) revealed there was no reliable relationship observed between final grades assigned and instructional method employed. This apparent independent relationship was interesting in light of the fact that statistically significant differences favoring the experimental group were found on the Structural Concrete Summative Posttest.

The adequacy of the materials used in the individually-paced format was also investigated. When the individually-paced materials were used in an institution outside the state of South Carolina, the results from one course (Surveying II) tended to support the idea that these materials could be used effectively elsewhere.

There were indications, however, that individually-paced students would have preferred learning the material (e.g., modules and media presentations) in a different manner. These indications were born out of information gathered from the Course Evaluations, Course Questionnaires and Instructor Questionnaires. Results from these measuring instruments indicated that students would have preferred more instructor input as well as a more rigidly defined course time-table. Students also complained that there were too many students per instructor in the individually-paced courses. On the other hand, instructors stressed the importance of the individually-paced method in terms of student ability and motivation. Viewing the disadvantages of the individually-paced method, the instructor-student ratio appeared to be the critical feature. If the ratio is reasonably low (e.g., one instructor for every ten students), the disadvantages of the individually-paced method appear to be minimal.